INNOVATIVE TECHNOLOGY
Summary Report

DOE/EM-XXXX

NTvision Video System for Waste Package Contents Documentation

Deactivation and Decommissioning Focus Area

Prepared for
U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

November 2002

INNOVATIVE TECHNOLOGY
Summary Report

NTvision Video System for Waste Package Contents Documentation

OST/TMS ID 3069
LAUR-01-2935

Deactivation and Decommissioning Focus Area

Demonstrated at
Los Alamos National Laboratory
Los Alamos, New Mexico

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine whether a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://www.em.doe.gov/ost under "Reports".

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SECTION 1
SUMMARY

Technology Summary

The U.S. Department of Energy (DOE) continually seeks safer and more cost effective data acquisition technologies for use in the decontamination and decommissioning (D&D) of nuclear facilities. To this end, the Deactivation and Decommissioning Focus Area (DDFA) of the DOE's Office of Science and Technology sponsors Large-scale Demonstration and Development Projects (LSDDP's) in which developers and vendors of improved or innovative technologies showcase products that are potentially beneficial to DOE projects and to others in the D&D community. Benefits sought include decreased health and safety risks to personnel and the environment, increased productivity, and decreased cost of operation.

Problem

The Los Alamos National Laboratory (LANL) waste inventory includes over 600 large fiberglass reinforced plywood (FRP) crates that contain various D&D waste items including: gloveboxes, tanks, furnaces, ductwork, machining equipment, filter media, and contaminated soil. Approximately 2,400 cubic meters of this waste is currently in storage at the Los Alamos solid waste disposal area, Technical Area (TA)-54, and another 3000 cubic meters will be generated as LANL facilities are decommissioned. All of this waste will be processed through the LANL Decontamination and Volume Reduction System (DVRS) and separated into Low-level Waste (LLW) and Transuranic (TRU) waste components. The LLW fraction will be disposed at LANL, TA-54, Area G, and the TRU fraction will be packaged and certified for ultimate disposal at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico.

The majority of FRP crates in storage at LANL contain waste generated in the mid to late 1970s. Most of the constituents of each FRP crate were partially documented when they were packaged; however, detailed information regarding specific waste items (e.g. compactable and non-compactable debris and miscellaneous building equipment) within each crate is not available. The WIPP Waste Acceptance Criteria requires that each waste container be visually examined, verified, and documented prior to acceptance at WIPP. Improperly packaged waste containers will result in excess cost imposed on LANL for repackaging. To meet these requirements, the current practice (baseline) at LANL, consists of opening crates sorting, segregating, decontaminating, size reducing, and recording the waste items manually by waste personnel.

The purpose of this demonstration is to determine if a video recording system called NTvision is an effective enabling technology applicable to the LSDDP for management of the information on the content of LLW and TRU waste crates. The NTvision system facilitates pictorial recording of the waste package contents as well as documentation of the date and time of the package loading. In this demonstration, NTvision was used to record the repackaging of LLW contents n B-25 LLW boxes. Although LLW crates were used in this demonstration, it is assumed the results obtained through this demonstration may be extrapolated to repackaging of TRU waste.

For NTvision to prove effective over the baseline technology, the system would be required to 1) be operated unattended in a non-radioactive area, 2) increase the efficiency and quality of the documentation of waste container contents, 3) increase the efficiency of the waste verification process, and 4) be less expensive to implement than a dedicated worker over the time period it will take to process 600 crates (e.g., 10 years).

How It Works

Designed to aid domestic and international nuclear safeguarding, NTvision software was developed by researchers in the Nonproliferation and International Security Division at LANL. LANL is currently utilizing NTvision software to continuously monitor sensitive, costly inventories worldwide, and have tested the camera in the Unites States, China, Russia, and elsewhere in Europe. Although NTvision was initially developed for video recording of security camera operations, it is also applicable for recording the

contents of containers as they are packaged for storage/disposal at LANL TA-54, Area G. The NTvision software is freely distributed among the DOE complex.

Similar to most television cameras, NTvision in conjunction with a video camera records movement of objects. The system has been demonstrated with small objects, similar in size to the smallest objects located in LANL's oversized TRU waste stream.

One advantage to using NTvision over conventional video cameras is the systems "on for action" mode wherein the system stops recording when there is no movement of the frame. Thus, the result is a relatively small electronic file that is readily retrieved and is non-subjective documentation of waste package contents. Another feature of the NTvision software is it's ability to electronically subtract the "before" and "after" images displaying the object that initiated the event. This feature is useful in waste packaging since an image will be produced for each object that is loaded in waste containers. Once installed, the system may be operated unattended.

The NTvision data acquisition software component is written in LABView 5.0 (National Instruments Corporation, Austin, Texas) and can be extended with additional functions written in LABView, C, or C++, or Java. Most major CCD camera types are supported. Event data is collected and formatted in real time.

The Netscape Communicator browser is used on NTvision data review to provide authenticated, secure access to the intranet-based NTvision data collection systems. NTvision requires no specialized client software other than the browser for data review. Administration of the NTvision HTTP server is also browser-based. Any standard desktop platform (Unix, WinNT/95/98, or Mac) with a browser may be used as a local or remote data review client. Data review clients may be limited to a secure local facility Intranet or extended via secure Internet connections to provided remote access. Remote modem connections use the standard PPP for connection to NTvision Intranet.

The NTvision software is capable of managing many cameras simultaneously so that recordings from many different locations may be accomplished using one centralized computer system.

Figure 1 shows how the software appears on a computer monitor. The calendar month appears in the left portion of the screen. The user can obtain the events for a specific day by clicking on the day of the month of interest. The events for that particular day are shown in the lower portion of the screen. The four frames in the upper portion of the screen are the initial event (upper left), the trigger event (upper right), the final event (lower right), and the object key (lower left).

The initial event is from the camera memory before the sequence or event was triggered. The trigger event starts the recording of events. The camera only stores the difference in each frame from the initial reference image. This allows a sequence to be recorded with minimal memory requirements. The third frame (lower right) shows the last frame taken. The final frame in the lower left shows the difference between the reference image and the final image. In this particular sequence, two wadded up items were added on the right side of the package, which in turn displaced the larger bundle.

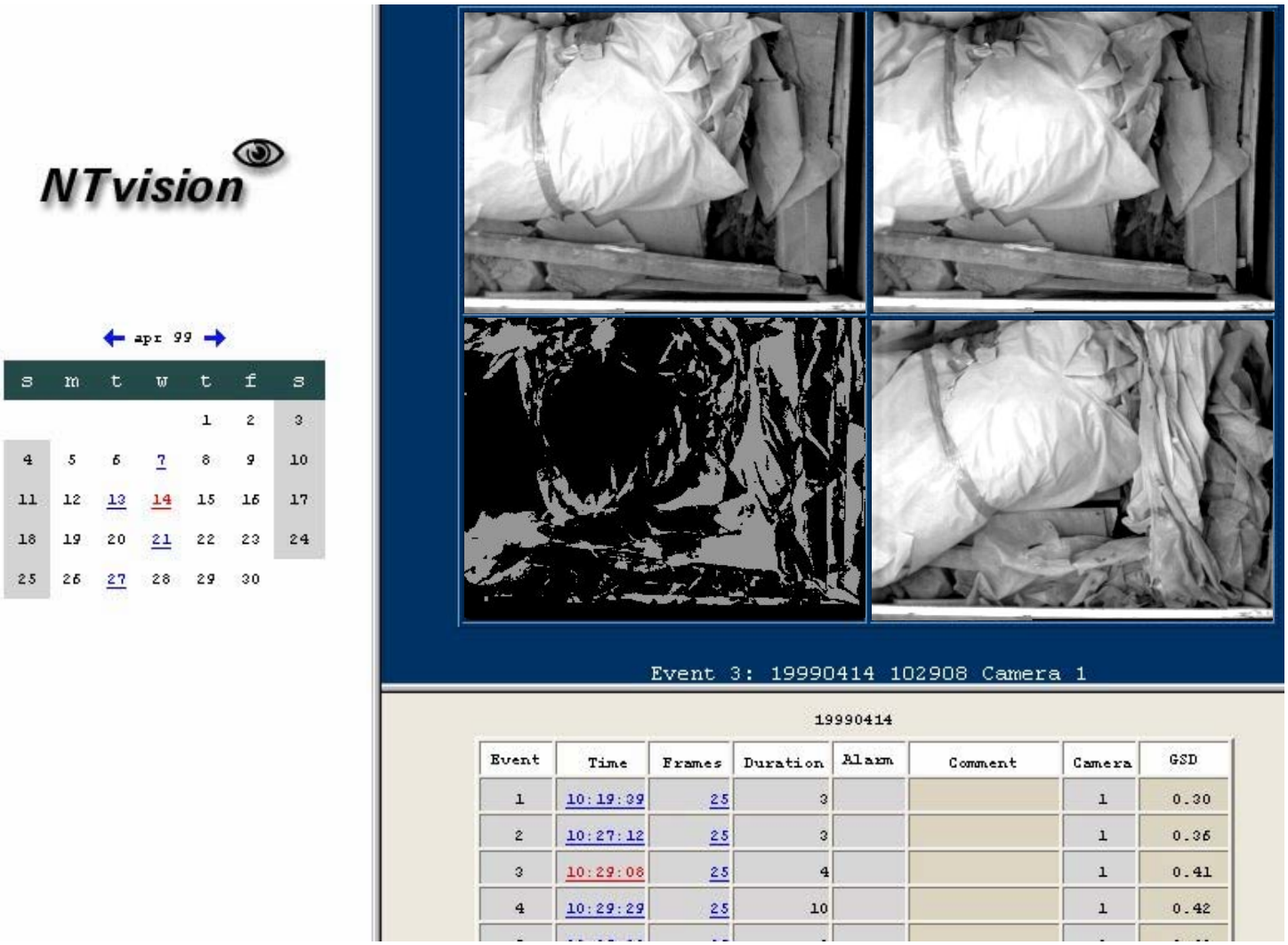

Figure 1: Screen display obtained during demonstration

Demonstration Summary

The Integrated Contractor Team (ICT) of the LSDDP demonstrated NTvision in September 2000 as part of the Large Scale Demonstration and Deployment Project, funded by the DDFA at the National Energy Technology Laboratory (NETL). The demonstration took place at the LANL's TA-54, Area G, within a PermaCon® structure inside of Dome 231.

For the demonstration, LLW items were removed from two damaged FRP crates the and placed in new B-25 waste storage containers as a repackaging effort. The items consisted of dirt, boards, sawdust, personal protective equipment, cellulose material and other objects of variable size. TRU waste items (gloveboxes and ductwork) were repackaged in one large transport container for safe storage at LANL, TA-54, Area G. TRU waste packaging was not part of this demonstration. The repackaging effort took place in a PermaCon® structure in which personnel were dressed in anti-contamination personal protective equipment (PPE).

The NTvision system consisted of one camera mounted on the roof of the PermaCon®, and a computer system set up on a desk and located outside the wall of the PermaCon®. The camera was aimed through a window-covered viewport on the ceiling of the PermaCon® and directly above the B-25 loading area.

NTvision was used to record each waste item as it was added to a new B-25 container. The baseline technology for this demonstration consisted of manual entry of waste descriptions in paper or electronic media by a dedicated worker inside the PermaCon® structure. One worker must be present during the entire loading process.

The use of NTvision met or exceeded expectations in that the system ran unattended and produced high quality electronic files documenting each item as it was placed in a new B-25. The video recordings and still images produced during the demonstration were of high resolution, layered objects were easily distinguishable, and light color and opaque objects were easily seen. Figures 2 and 3 provide images produced by NTvision during the demonstration. The image in the upper left of these figures shows the reference frame prior to detection of movement. The frame that triggered the event is shown in the upper right, and the ending reference image is shown in the lower right. The object key, shown in the lower left, shows the difference between the first reference image, and ending reference frame in this case the added bundle. Because of its ease of operation, the quality recordings produced, and accessibility to the data produced via the Internet, NTvision software proved that it would enhance the review process of the waste management paperwork and improve quality assurance that the waste has been properly characterized and disposed.

Since NTvision may be operated unattended, a cost savings was projected since a dedicated worker is not required to record each item as it is repackaged. Schedule impact from data recording and associated paperwork will also be minimized, since all files are stored and readily accessible from any computer via the Internet. Worker safety was enhanced since one less person will be present in the controlled work area and the associated radiation dosage was avoided.

Based on this successful demonstration of NTvision, LANL plans to use an NTvision system with multiple cameras for recording the packaging of all TRU containers prior to shipment to WIPP.

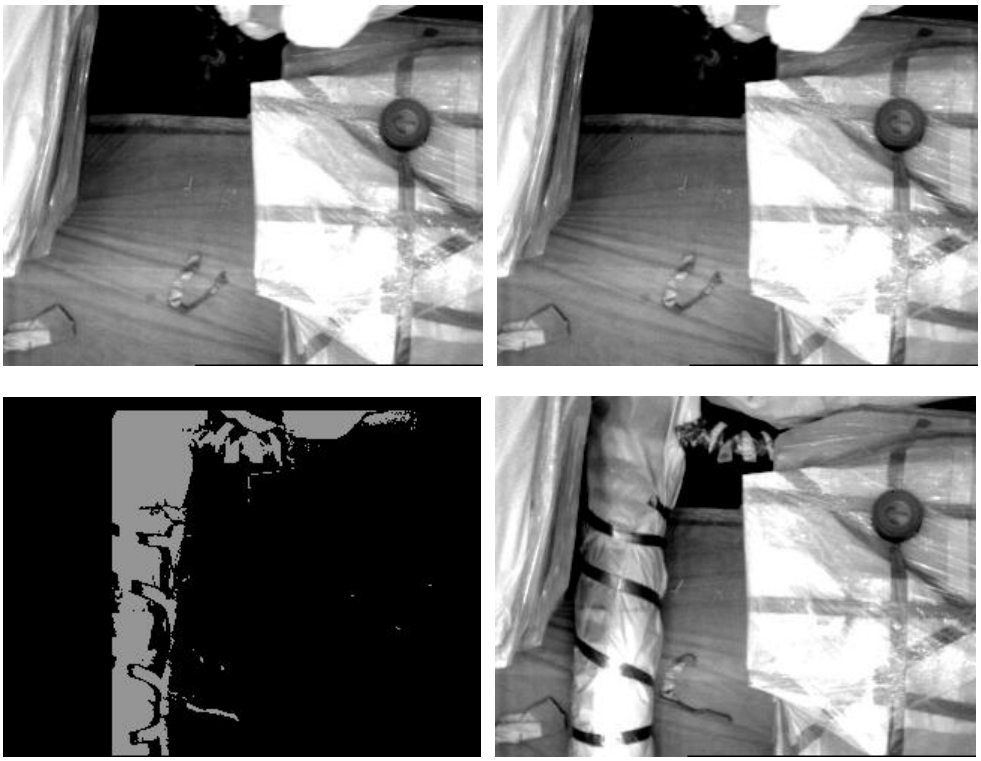

Figure 2: NTvision image of the addition of a plastic wrapped bundle.

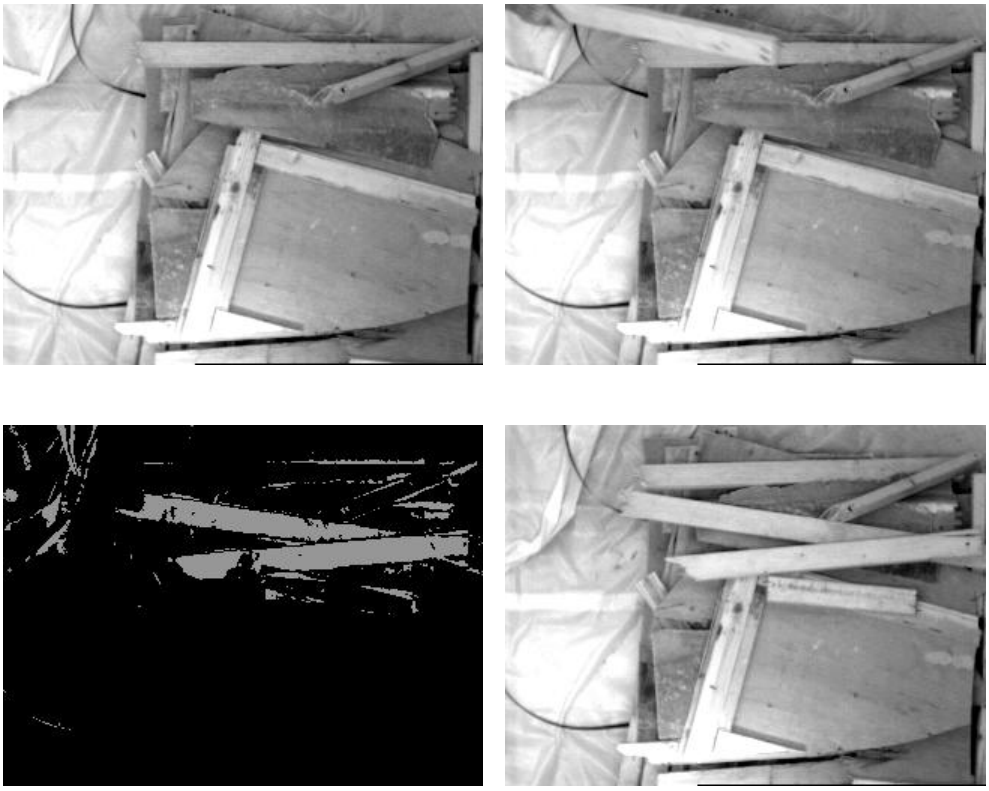

Figure 3: NTvision image of the addition of plywood material to a B-25 box.

Benefits:

- NTvision provides an accurate means of recording waste items as they are placed in waste containers.
- The electronic files produced by NTvision are small (~100 kilobytes [kbytes]), and are suitable for storage and manipulation on a computer.
- The system may be run unattended.
- Improves throughput time and accuracy of recording waste items
- Less manpower required for recording of waste items.

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Other

All published Innovative Technology Summary Reports are available on the OST Web site at http://www.em.doe.gov/ost under "Reports". The Technology Management System (TMS), also available through the OST Web site, provides information about OST programs, technologies, and problems. The OST/TMS ID for NT vision Video System is 3069.

SECTION 2
TECHNOLOGY DESCRIPTION

Overall Process Definition

The overall objective of the demonstration was to evaluate NTvision for its ability to record waste items as they are placed into B-25 boxes and other waste container types at LANL. If successful, the system would accomplish the following:

- The video recordings that are produced should be of a size manageable on a computer system.
- The files produced would be electronically stored and filed under a specific waste container id.
- The files can be easily edited to eliminate unwanted triggered events for the purpose of waste data review.
- The images would have good resolution and color contrast in order to distinguish between items.
- The time and documentation required to verify that the waste records match the waste items packaged would be significantly reduced.
- The time required to manually record each waste item would be greatly decreased since a dedicated worker would not be needed.

The baseline technology is manual entry of waste descriptions in paper or electronic media. Specifically, using NTvision to record waste items as they are placed in waste containers would be more accurate and faster than the baseline technology.

The demonstration took place at the LANL TA-54, Area G within a PermaCon® located inside of Dome 231. The PermaCon® was equipped with the necessary engineering and radiation controls for safe handling of radioactive waste containers. The setup allowed for access control in accordance with the radiation control plan developed for the demonstration.

The NTvision demonstration system consisted only of a camera and a computer system. The camera used for this particular demonstration had automatic focusing capabilities. The camera was positioned on the roof of the PermaCon® and aimed through a window port directly above the B-25 waste container loading area. LANL workers removed waste items from two damaged FRP crates, then placed them into a new B-25 container beneath the view of the camera. NTvision produced an electronic file of the addition of each item. Each event was stored electronically on the system computer. The video recordings produced by NTvision are black and white, and have good resolution.

System Operation

The NTvision system was installed and configured by a trained LANL employee. Once setup, the system operated unattended, with periodic system checks performed by the responsible LANL employee. Other operational parameters are shown in Table 1.

Table 1: Operational parameters and conditions for NTvision demonstration

Operational Parameter	Los Alamos Application
Work Area Description	30' x 50' PermaCon® within 100 x 300 indoor area.
Work Area Hazards	Potential radiation contamination hazard during loading and unloading of large crates
Waste Container Size	B-25 (4 ft. x 4 ft. x 7 ft.)
Work Crew	Four laborer/operators One Technical Staff Member (TSM) for computer support One site supervisor Two radiation control technicians
Additional Support Personnel	None
Training	NTvision training for TSM
Equipment Design Purpose	To provide a record of waste items placed as they are placed into containers.
NTvision hardware requirements	Internet connection Computer Cable Interface Card
Personnel Protective Equipment	Safety glasses Steel toed boots Hardhats Thermo luminescent detector, ALOKA and alarming dosimeters based on Los Alamos National Laboratory requirements
Utilities	120 Volt power to computer and camera

SECTION 3
PERFORMANCE

Demonstration Plan

Prior to the demonstration, LANL selected two damaged FRP crates that needed to be repacked into metal overpacks for safe storage at TA-54, Area G. LLW generated from the repackaging effort (i.e. FRP crate material, nails, sawdust, dirt, and plastic) were placed in B-25 containers. NTvision remained on and unattended to record each waste item as it was placed in a new B-25 container.

As part of the demonstration, the time required to unsheathe FRP crate material and unpack each of the waste items in the FRP then repackage the LLW waste items in new B-25 containers was recorded. Other time data recorded included NTvision system setup, mobilization, daily preparation time, plans and permits, and meetings. Labor requirements were also recorded for these tasks. Other recorded data included radiation exposure, costs of labor, materials and equipment. Labor costs included demonstration personnel, support personnel, and labor costs for plans and permits. The specific functions for each worker for the demonstration are as follows:

- Radiation control technicians (RCTs) were present to survey the containers, gather smears and direct readings as laborers worked, monitor air inside the PermaCon®, collect results of radiation contamination from repackaging efforts, and implement radiation protection controls to avoid contamination exposure to workers.

- A forklift operator moved damaged FRP crates and waste packages generated from FRP unsheathing and repackaging, in and out of the PermaCon®.

- Laborers unsheathed damaged FRP crates and removed plywood covering, dirt, nails, cellulose material and other waste items beneath the NTvision camera view.

- A test engineer communicated with laborers to assure sufficient data was generated from NTvision.

- A LANL supervisor oversaw all work performed to assure work was done in a safe manner.

- A LANL waste management coordinator (WMC) ensured all packaged waste generated was properly labeled and all waste management paperwork verified and approved for disposal at TA-54, Area G, LLW disposal pits.

- A Section leader reviewed waste profile forms (WPF) and chemical waste disposal requests (CWDR) to assure all waste data was correct.

- A Data reviewer reviewed and validated WPFs and CWDRs to assure waste in packages match paperwork description, and all waste classifications are valid under LANL waste requirements, quality assurance guidelines, and LANL waste acceptance criteria guidelines.

The overall test objective of the NTvision demonstration was to assess the feasibility and utility of NTvision for loading waste into LLW containers and the possibility of applying the technology to packaging and certifying TRU containers that are destined for disposal at WIPP.

Specific objectives were to determine:

- Ease of technology implementation
- Produce video files of size suitable for storage on computer and easy to edit.
- Decontamination ease and maintenance costs
- Cost-effectiveness and risk reduction offered by the technology.
- Identify NTvision system configuration that best supports the LANL operations requirements.

Results

Over the one-month test period, video recordings of approximately 6 B-25s of waste were generated from the unsheathing of two FRP crates. The video recordings and still images that were produced during the demonstration were of high resolution of all objects including light color and opaque objects. Because of its ease of use, and the quality images produced, NTvision proved that it would enhance the review process of the waste management paperwork and improve quality assurance that the waste has been properly characterized and disposed. It was also evident from the demonstration that the baseline technology (preparing documentation, review, validating and approving waste management paperwork) would require many more man-hours than using NTvision since the data is recorded electronically, and easily accessible for any remote location.

Each of the test objectives is addressed individually below:

- **Ease of technology implementation**
  Implementation of the technology was straightforward. System set-up took only one hour. The NTvision unit requires only sufficient lighting. The system requires very little training and is very easy to operate.

- **Produce video recordings of size suitable for storage on computer**
  The average size of the electronic files (Mpegs) produced by NTvision was100 Kbytes.

- **Decontamination ease and maintenance costs**
  There are no decontamination concerns associated with operation of NTvision since all equipment was located external to the test area. If, however, NTvision equipment such as cameras are set up in a radiological controlled environment, the cost of the cameras would be insignificant compared to the time and increased quality of validation associated with documenting and verifying waste items.

- **Identify NTvision system configuration that best supports the LANL operations requirements.**
  The recording procedure used at the LANL demonstration involved moving waste containers to a repackaging area (i.e. below the NTvision camera), and using NTvision to film the placement of waste items within a new B-25 waste container. The system would easily accommodate many more applications such as the LANL DVRS facility, where each processing cell within the facility would be equipped with an NTvision camera that is tied to a centralized computer system.

- **Cost effectiveness and risk reduction offered by the technology.**
  The cost analysis is discussed in a separate section, which follows. Generally speaking, the approximately $4500 investment in an NTvision camera and associated equipment saves a full time waste data recorder in the waste generation area. This person's cost substantially overcomes the low initial cost.

SECTION 4
TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

NTvision was selected for demonstration by the Los Alamos ICT to address a need identified by the Los Alamos Solid Waste Operations staff during project meetings with the LSDDP Technology Selection Committee. The baseline DVRS process did not include plans/technologies for recording repackaged waste items before placing them in a new B-25 container.

The major benefit of using NTvision for recording is that it provides LANL management with a simple and inexpensive means of documenting waste items as they are placed in new B-25 waste containers. This technology can easily be modified for meeting visual examination and packaging requirements for certified TRU waste destined for WIPP. The electronic files produced by NTvision are small enough to be stored on a computer system and reviewed as needed. Although there are many camera systems commercially available, there currently are no competing technologies that may be applied as simply and inexpensively as NTvision.

Technology Applicability

NTvision has a wide range of applications for recording waste container loading as well as documenting material handling activities around the DVRS.

Patents/Commercialization/Sponsor

The LANL holds the patent for NTvision.

SECTION 5
COST

Methodology

This section provides a cost-effectiveness analysis that compares the costs for the improved and baseline technologies used to record waste management data at the LANL. To approach realistic implementation costs, additional assumptions were invoked regarding the greater efficiency of a production, rather than a demonstration setting. This analysis determined that the cost of the improved technology is much less than the baseline for the conditions that were used during the demonstration.

The cost analysis considers two options: 1) purchase system components and install NTvision then use the system to record waste packaging activities or, 2) employ the baseline option where one worker is dedicated to record data, then complete and distribute necessary paperwork through the waste certification process. The baseline costs are from direct observation of personnel during the waste packaging demonstration and shown on Table 2. Therefore, the difference between the baseline and NTvision costs is the cost of this worker.

The objective of the cost analysis was to provide interested parties with a cost estimate for implementation of the NTvision technology on a production scale at a DOE site. The actual demonstration costs incurred at LANL formed the basis of the cost estimate.

Key assumptions for the cost estimate are listed below. Other assumptions and details about the cost analysis are presented in Appendix C.

1. A DOE site, such as LANL, will purchase all equipment necessary for NTvision operation.

2. Other laborers provided by the DOE site to accomplish waste repackaging including a site supervisor, site health physics supervisor, site safety officer, and site radiation control technician are not included since there is no difference in their respective job functions and duration for both options. The site supervisor and site health physics supervisor are senior staff who manage the FRP repackaging project at the DOE site, including preparation of plans, permits, and approvals.

3. Baseline costs incurred are due to a technician required to record waste items during waste processing. The baseline costs are determined by assuming a processing rate of 50 waste crates per year (1 FRP crate per week) and a total of 2000 person hours per year.

4. Fully burdened labor rates for LANL personnel were used in the estimate.

5. There is no operational protocol for operation of NTvision other that one time set-up and camera installation.

6. No permits were required.

7. No overhead factors were applied to other direct costs.

8. Validation/verification process for waste generated is the same for both NTvision and the baseline.

Table 2: NTvision and Baseline Waste Certification Process Man-hours

Job Title/Task	Total Time per waste stream (hours)
Identify work, activities, and processes that would potentially generate waste	2
Assigns a generator to each waste generating process.	0.25
Monitor process for compliance and consistency	1.5
Total	3.75
Generate Waste Stream List (Form GWCP-1)	4
Generate Waste Stream Data (Form GWCP-2)	12
Prepare preliminary Waste Profile Form	3
Establish controls for GWCP-2	1
Monitor process for compliance and consistency	1.5
Waste storage in accordance with certification package	2
Total	23.5
Generate Waste Stream Data (Form GWCP-2)	12
Review GWCP-1 and GWCP-2 to WCO for review and verification	1
Classification of waste forms for Waste Acceptance Criteria (WAC)	0.5
Sign GWCP-1 and GWCP-2 after review	0.5
Establish controls for GWCP-2	1
Create file to maintain information relevant to waste generating process	0.5
Compare GWCP-2 to WPF	1
Determine if waste meets LANL WAC	0.5
Complete GWCP-3	2
Total	19
Generate Waste Stream Data (Form GWCP-2)	12
Monitor process for compliance and consistency	1.5
Prepare CWDR or TWSP	2
Review/Verify CWDR or TWSP Data.	2
Waste storage in accordance with certification package	2
Total Operator – Waste Disposal	19.5 4
Spotter – Waste Disposal	4
Total	8

Cost Analysis

To develop an estimate for implementation, an annual basis was chosen. The U. S. Army Corps of Engineers developed the cost estimates for both the baseline and the NTvision activities. Activities were grouped under higher level work titles per the work breakdown structure shown in the Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary (HTRW RA WBS) (U.S. Army Corps of Engineers, 1996). The cost estimates are included in Appendix C.

Cost Conclusions

The cost estimate calculates a reasonable cost for implementation of the NTvision system at a DOE site. Using the baseline system costs as a basis, costs for the NTvision mobilization, sampling and testing, and demobilization activities were developed. The scope of work represents a well-established work routine, and costs per unit were based on 2000 total hours of waste container repackaging in one year and the demonstrated effort per unit.

Although the initial cost of equipment and mobilization of the NTvision system is higher than the baseline activity, the cost is quickly recovered as more crates are processed. The time saved by using the NTvision system results from the elimination of a full time Waste Data Recorder and equates to a savings of approximately $1,867 per waste crate or 22%.

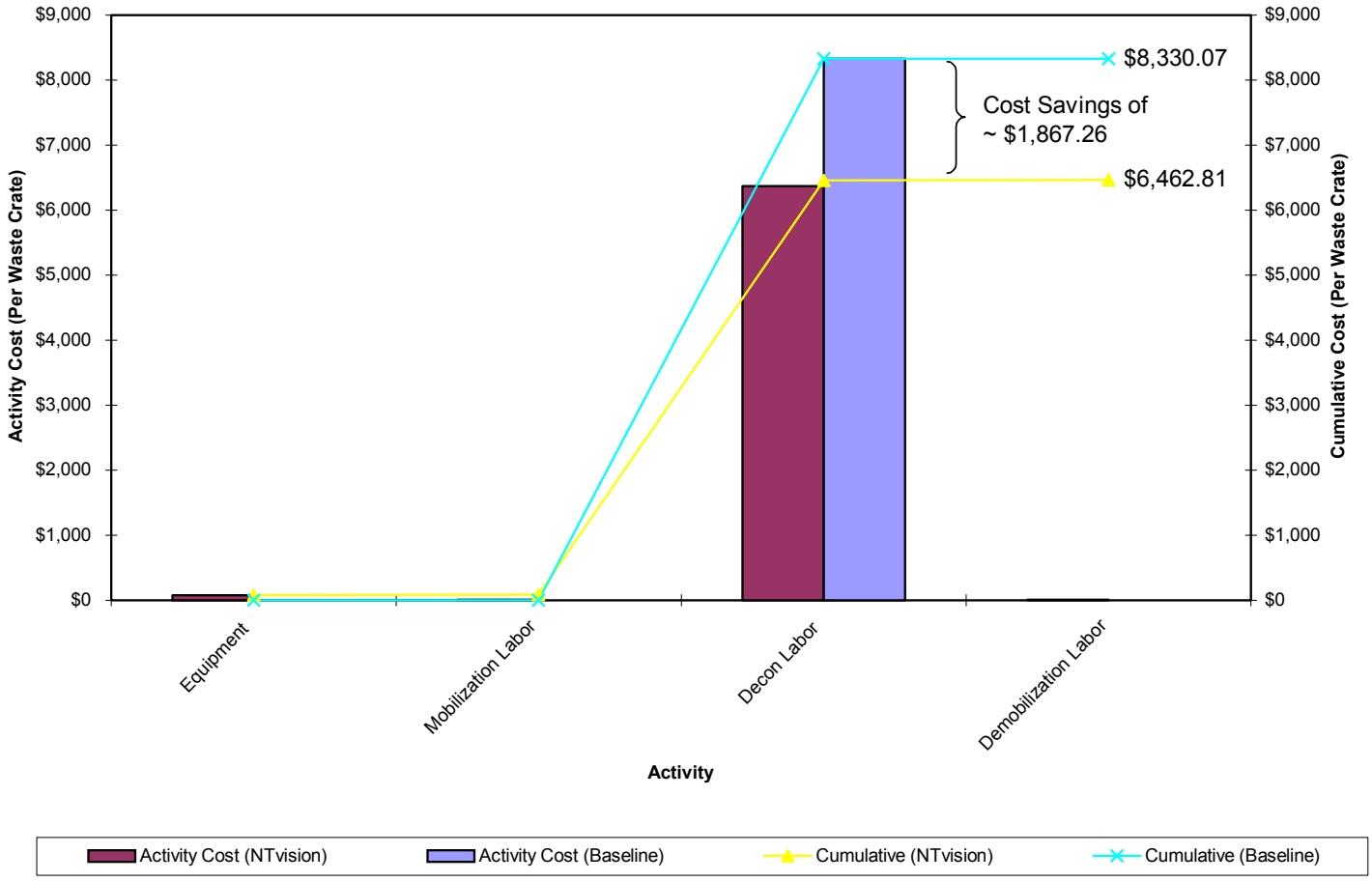

Figure 4: Unit Costs for NTvision System vs. Baseline

SECTION 6
REGULATORY AND POLICY ISSUES

Regulatory Considerations

The NTvision system could potentially be certified be certified for visual examination as defined in the WIPP WAC.

Safety, Risks, Benefits, and Community Reaction

Worker Safety
No special worker safety considerations required for operation of NTvision. Additionally, worker safety is greatly improved given that the NTvision system takes the data recording aspect out of the radiological controlled area.

Community Safety
Community safety is not adversely affected by operation of NTvision.

Environmental Impact
There is no negative environmental impact associated with use of NTvision. A potential positive impact could be realized with using NTvision since no waste is generated with it's use.

Socioeconomic Impacts and Community Reaction
There are no socioeconomic impacts associated with NTvision. Community reaction is likely to be positive given that the NTvision system takes the data recording aspects out of the radiological controlled area.

SECTION 7
LESSONS LEARNED

Implementation Considerations

The NTvision demonstration at LANL yielded several lessons learned including:

- There was substantial interest from LANL management and staff not involved with the FRP repackaging effort.
- Scheduling LANL support labor is critical, and especially when competing for other operation activities occurring concurrently with the demonstration at LANL, TA-54, Area G.

Technology Limitations and Needs for Future Development

The Los Alamos demonstration conclusively proved that NTvision will provide an acceptable means of recording waste packaging LLW activities with little modification (i.e. audio capabilities) for visual examination and packaging for the purpose of certifying TRU waste items destined for WIPP. It provides DOE a simple means of recording all waste items as they are placed in containers. Additionally, the electronic files produced are easily stored on a computer system can easily be edited for desired waste data reports. If implemented, the NTvision files may be obtained through an Internet connection to any desktop personal computer (PC).

For the DOE application, the only shortcoming is that NTvision does not currently offer audio to accompany the video recordings that are produced. This would provide explanatory information to inform the viewer what is in the field of view.

NTvision is capable of managing many cameras simultaneously so that video records from many different locations may be recorded using a centralized computer system.

Technology Selection Considerations

Considerations for selection of this technology include:

- Suitable speed internet connection
- Backup power

APPENDIX A
REFERENCES

IT Corporation, 1999, Test Plan for Demonstration of NTvision Video System for Waste Package Contents Documentation.

Los Alamos National Laboratory Waste Acceptance Criteria, 1999.

Department of Energy, Waste Isolation Pilot Plant Waste Acceptance Criteria, 1999.

Los Alamos National Laboratory, “NTvision Technology Brief”, Technical Note: NIS-3:99:15, March 1999.

U.S. Army Corps of Engineers, 1996, Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary

“Documenting Acceptable Knowledge Characteristics as dictated by the WIPP Hazardous Waste Permit”, August 8, 2000.

APPENDIX B

Images Generated During the NTvision Demonstration

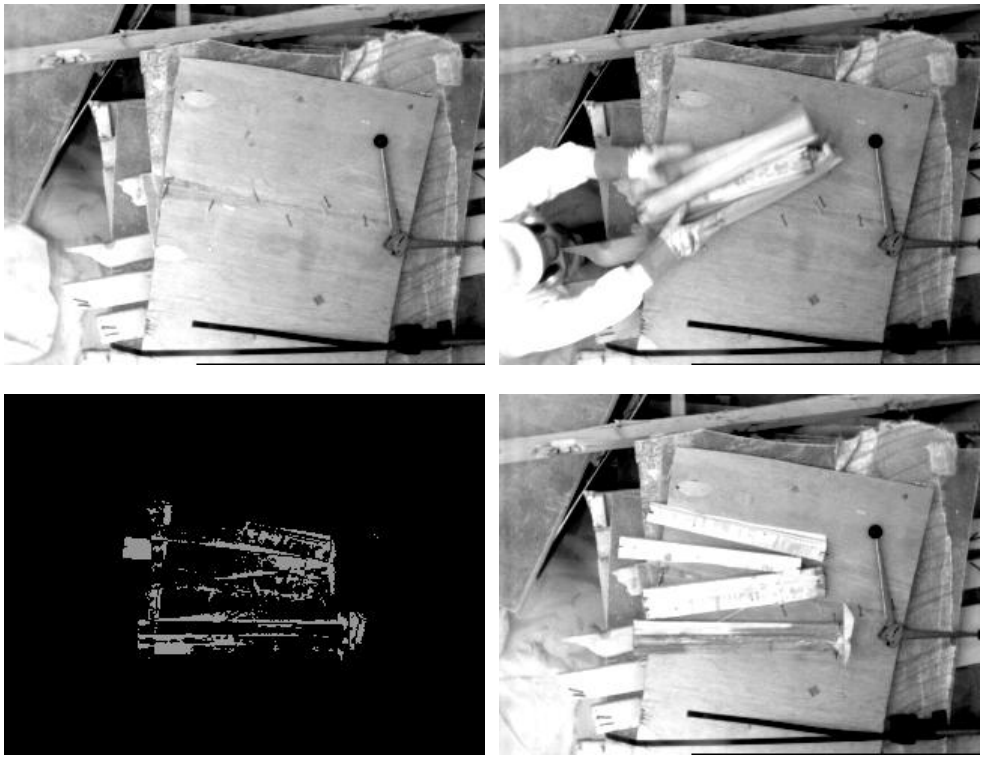

Figure B-1: Worker loading Crate Debris into B-25 Waste Container

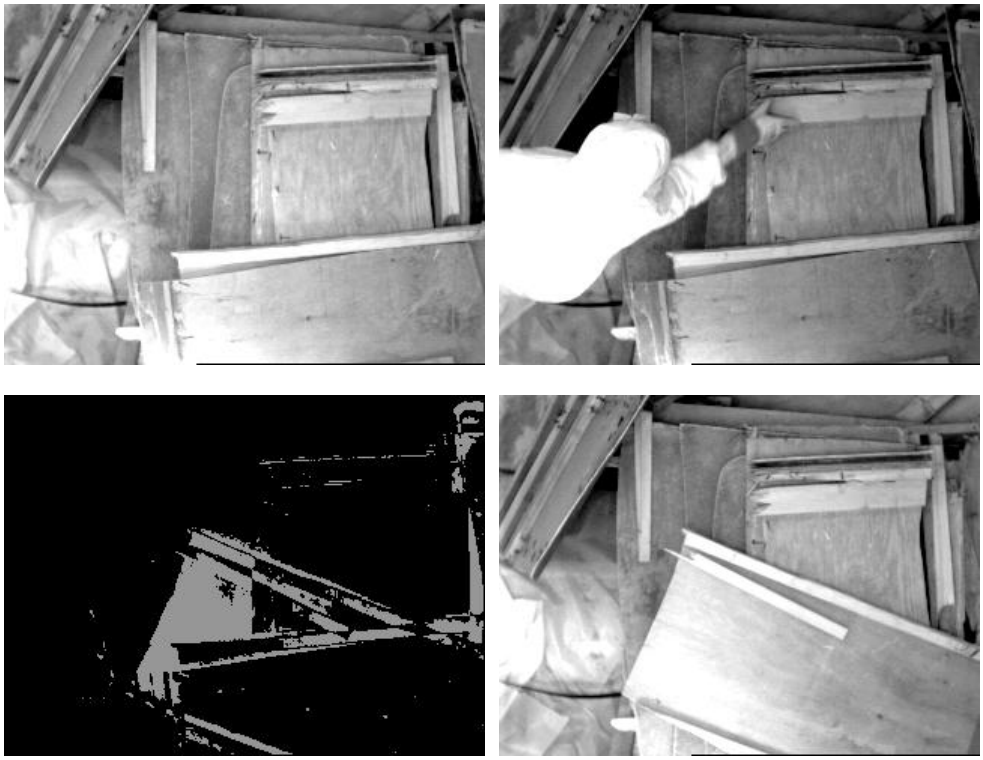

Figure B-2: Worker Repositioning Crate Debris in B-25 Waste Container

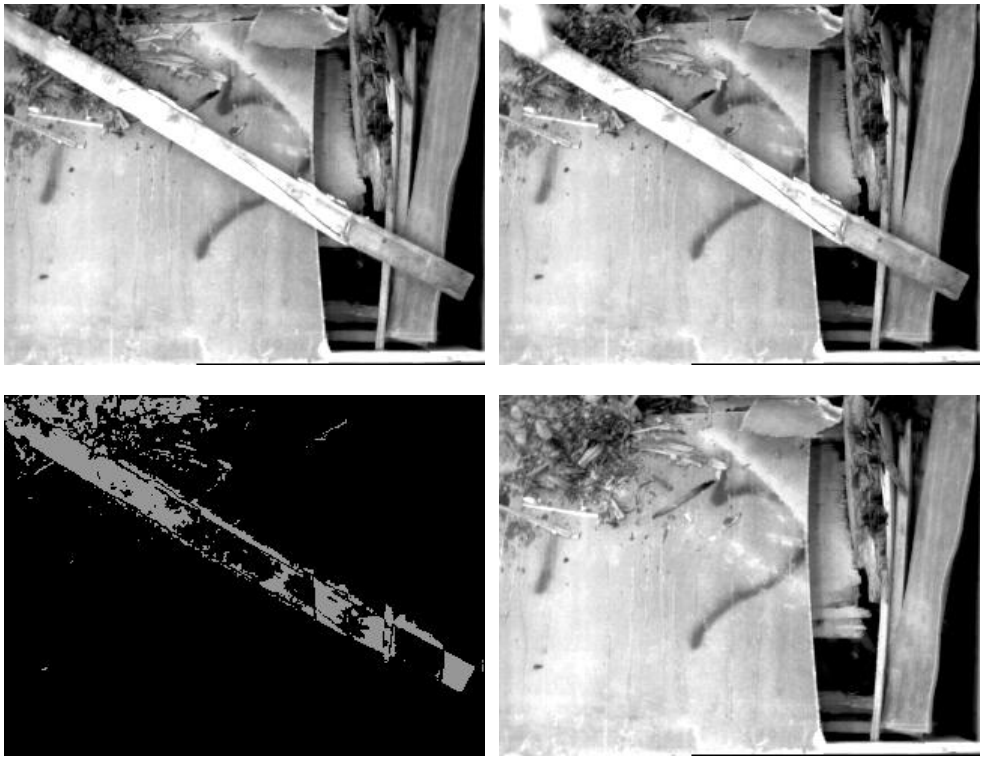

Figure B-3: NTvision image of dirt being added to B-25 Waste Container

APPENDIX C
COST DETAILS

Basis of Estimated Cost

The data from the demonstration compiled the labor costs for the baseline technology (manual data collection) for waste certification and was listed in Table 2 of the text. Data from that table was used for both the baseline and NTvision cost analysis with the exception that a full-time person would be necessary for the baseline case. Use of NTvision requires the time to purchase, setup and position the camera for monitoring the crate filling operation.

Activity Descriptions

The scope of each work breakdown structure (WBS) element, computation of production rates, and assumptions (if any) for each work activity are described in this section.

Mobilization and Preparatory Work (WBS 33.1.01)
Mobilization of NTvision equipment consisted of setting up the camera system above the PermaCon®, setting up the computer system and connecting the computer system at LANL, TA-54, Area G.

The NTvision system and camera will be purchased and used in the Decontamination and Volume Reduction System (DVRS) process at LANL. The time required to train a LANL TSM to operate NTvision is approximately 2 hours. The time required to install, configure, and test NTvision on the computer system was 2 hours using one TSM during the demonstration. The time required for a laborer/operator to install the camera above the PermaCon® structure was 2 hours.

For the baseline technology, there are no mobilization costs.

Submittals/Implementation Plans: Plans were assumed to be complete prior to the start of the work. No permits were required. It was estimated that one additional LANL technician would be required to be present as all new B-25 waste containers are packaged.

Monitoring, Sampling & Testing (WBS 33.1.02)

It was assumed that there are no cost incurred for obtaining the NTvision electronic files for the purpose of waste verification/validation since the files will be readily available via internet at desk top. Waste verification and validation includes the manpower and costs associated with processing the appropriate waste management paperwork in order to dispose of the generated waste onsite at LANL, TA-54, Area G (See Table C-3 of this Appendix for verification/validation description, responsible individuals, and time and cost associated with waste verification/validation.)

Baseline costs incurred are due to the waste verification and validation step listed above as well as an additional technician required to record the waste items. The baseline costs for waste data recording are determined by assuming a processing rate of 50 waste boxes per year (1 FRP crate per week), and a total of 2000 man-hours per year. For the purpose of the demonstration, the estimated time for the technician to record waste items for a one crate per week processing operation rate was 40 hours.

Decontamination (WBS 33.1.02)
Decontamination of equipment includes surveying and releasing test equipment following LANL requirements (LIR402-704-01.2), performing decontamination of equipment as necessary, writing up survey results, and releasing test equipment. Since the camera and computer system remained outside of the PermaCon® and were not contaminated during the entire duration of the demonstration, it is assumed that either will require decontamination. Additionally, there are no decontamination costs associated with the baseline technology.

Demobilization (WBS 33.1.21)

Disassembly of Equipment and Demobilization of Personnel: Demobilization of NTvision equipment consisted of removing cameras and the computer system from the area and relocating them to another location. For this cost estimate it was assumed that the time required to demobilize the equipment was the same as that required for system set-up, with the exception of 2 hours of TSM training required for operating NTvision. There are now demobilization costs associated with the baseline technology.

For the baseline technology, there are no demobilization costs.

Equipment Costs

The NTvision system software subsequent to this demonstration was obtained free of charge, and is free to all U.S. Department of Energy (DOE) complex laboratories. The cost of this system including one camera, computer, and wiring was $4,477. The lifetime of all NTvision supporting equipment is expected to be 5 years.

It is assumed that the baseline technology requires no initial cost.

Cost Estimate Summary

Figures C-1 and C-2 summarize the estimates developed by the U. S. Army Corps of Engineers for an annual campaign of 50 crates. The costs per glovebox were determined from these estimates. Details of the waste certification costs used in the cost estimates are summarized in C-3. The tables break out each member of the crew, each labor rate, each piece of equipment used, each equipment rate, each activity duration, and all production rates so that site-specific differences in these items can be identified and a site-specific cost estimate can be developed

Table C-1: NTvision Estimated Implementation Cost

Title	Labor	Equipment	Other Costs	Unit of Measure	Unit Cost($)	Quantity	Subtotals
Mobilization and Preparatory Work (WBS 33.1.01)							$4,477.06
Initial Assembly and Setup	Laborer/Operator			Hour	$49.06	2	$98.12
	Technical Staff Member			Hour	$90.86	4	$363.44
NTvision Hardware		Computer		Lump	$3,000.00	1	$3,000.00
		Camera		Lump	$1,000.00	1	$1,000.00
		Cable		Lump	$10.00	1	$10.00
		Interface Card		Lump	$5.50	1	$5.50
Monitoring, Sampling & Testing (WBS 33.1.02)							$318,383.68
NTvision Monitoring and Waste Verification and Validation							
	Section Leader			Hour	$90.86	188	$17,081.68
	Waste Generator			Hour	$90.86	1175	$106,760.50
	Waste Certification Official			Hour	$90.86	950	$86,317.00
	Waste Management Coordinator			Hour	$90.86	975	$88,588.50
	Operator			Hour	$49.09	200	$9,818.00
	Laborer (spotter)			Hour	$49.09	200	$9,818.00
Demobilization (WBS 33.1.21)							$279.84
Disassembly of Equipment							
	Laborer/Operator			Hour	$49.06	2	$98.12
	Technical Staff Member			Hour	$90.86	2	$181.72
TOTAL COST:							$323,140.58

The overall cost per glovebox for the NTvision system is $6,462.81.

Table C-2: Baseline Estimated Implementation Cost

Title	Labor	Equipment	Other Costs	Unit of Measure	Unit Cost($)	Quantity	Subtotals
Mobilization and Preparatory Work (WBS 33.1.01)							$0.00
							$0.00
							$0.00
Monitoring, Sampling & Testing (WBS 33.1.02)							$416,503.68
Baseline Monitoring and Waste Verification and Validation							
	Waste Data Recorder				$49.06	2000	$98,120.00
	Section Leader			Hour	$90.86	188	$17,081.68
	Waste Generator			Hour	$90.86	1175	$106,760.50
	Waste Certification Official			Hour	$90.86	950	$86,317.00
	Waste Management Coord.			Hour	$90.86	975	$88,588.50
	Operator			Hour	$49.09	200	$9,818.00
	Laborer (spotter)			Hour	$49.09	200	$9,818.00
Demobilization (WBS 33.1.21)							$0.00
Disassembly of Equipment							
							$0.00
							$0.00
TOTAL COST:							$416,503.68

The overall cost per glovebox for the baseline activity is $8,330.07.

Table C-3: NTvision and Baseline Waste Certification Costs

Job Title/Task	Dollars per hour	Total Time per waste stream (hours)	Total Cost
Section Leader			
Before waste generation			
Identify work, activities, and processes that would potentially generate waste	$90.86	2	$181.72
Assigns a generator to each waste generating process.	$90.86	0.25	$22.72
During and after waste generation			
Monitor process for compliance and consistency	$90.86	1.5	$136.29
Subtotal		3.75	$340.73
Waste Generator			
Before waste generation			
Generate Waste Stream List (Form GWCP-1)	$90.86	4	$363.44
Generate Waste Stream Data (Form GWCP-2)	$90.86	12	$1090.32
Prepare preliminary Waste Profile Form	$90.86	3	$272.58
Establish controls for GWCP-2	$90.86	1	$90.86
Monitor process for compliance and consistency	$90.86	1.5	$136.29
During and after waste generation			
Waste storage in accordance with certification package	$90.86	2	$181.72
Subtotal		23.5	$2135.21
Waste Certification Official			
Before waste generation			
Generate Waste Stream Data (Form GWCP-2)	$90.86	12	$1090.32
Review GWCP-1 and GWCP-2 to WCO for review and verification	$90.86	1	$90.86
Classification of waste forms for WAC	$90.86	0.5	$45.43
Sign GWCP-1 and GWCP-2 after review	$90.86	0.5	$45.43
Establish controls for GWCP-2	$90.86	1	$90.86
Create file to maintain information relevant to waste generating process	$90.86	0.5	$45.43
Compare GWCP-2 to WPF	$90.86	1	$90.86
Determine if waste meets LANL WAC	$90.86	0.5	$45.43
After waste generation			
Complete GWCP-3	$90.86	2	$181.72
Subtotal		19	$1726.34
Waste Management Coordinator			
Before waste generation			
Generate Waste Stream Data (Form GWCP-2)	$90.86	12	$1090.32
Before and after waste generation			
Monitor process for compliance and consistency	$90.86	1.5	$136.29
After waste generation			
Prepare CWDR or TWSP	$90.86	2	$181.72
Review/Verify CWDR or TWSP Data.	$90.86	2	$181.72
Waste storage in accordance with certification package	$90.86	2	$181.72
Subtotal		19.5	$1771.77

Continued			
Laborer/Operator			
After waste generation			
Operator – Waste Disposal	$49.06	4	$196.24
Spotter – Waste Disposal	$49.06	4	$196.24
Subtotal		8	$392.48
Total cost per waste stream			**$6,366.50**

APPENDIX D
ACRONYMS AND ABBREVIATIONS

CWDR	Chemical Waste Disposal Request
DOE	U.S. Department of Energy
D&D	Decontamination and Decommissioning
DDFA	Deactivation and Decommissioning Focus Area
DVRS	Decontamination and Volume Reduction System
FRP	Fiberglass Reinforced Plywood
HTRW RA WBS	Hazardous, Toxic, Radioactive Waste Remedial Action Work Breakdown Structure
ICT	Integrating Contractor Team
Kbytes	Kilobytes
LANL	Los Alamos National Laboratory
LLW	Low Level Waste
LSDDP	Large-scale Demonstration and Deployment Project
NETL	National Energy Technology Laboratory
OST	Office of Science and Technology
PPE	Personal Protective Equipment
RCT	Radiation control technicians
TA	Technical Area
TMS	Technology Management System
TSM	LANL Technical Staff Member
TRU	Transuranic
WAC	Waste Acceptance Criteria
WBS	Work Breakdown Structure
WIPP	Waste Isolation Pilot Plant
WPF	Waste Profile Form